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1904/104
CHEMISTRY TECHNIQUES I
Oct./Nov. 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN SCIENCE LABORATORY TECHNOLOGY

MODULE I

CHEMISTRY TECHNIQUES I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non-programmable scientific calculator(battery operated).
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer **ALL** the questions in section **A** and any **TWO** questions from section **B**.*
*Each question in section **A** carries **4** marks while each question in section **B** carries 20 marks.*
Maximum marks for each part of a question are indicated.
Candidates should answer the questions in English.

This question paper consists of 6 printed pages.

Candidates must check the question paper to ascertain that all the pages are printed and that no questions are missing.

Turn over

SECTION A (60 marks)

*Answer **ALL** the questions in this section.*

1. Calculate the pH of a solution of NaOH containing 8 g in 250 cm^3 of solution. (Na = 23, O = 16, H = 1). (4 marks)

2. Define an acid and a base according to the following theories:

   (a) Lewis; (2 marks)

   (b) Brönsted-Lowry. (2 marks)

3. Describe how a muffle furnace is used for sample digestion in a chemistry laboratory. (4 marks)

4. (a) Define solubility product. (1 mark)

   (b) Calculate the solubility of bismuth sulfide (Bi_2S_3) if its solubility product has a numerical value of 1.0×10^{-70}. (3 marks)

5. Name the following organic compounds using IUPAC rules:

   (a) $CH_3(CH_2)_4CH_3$ (1 mark)

   (b) $CH_3COOC_3H_7$ (1 mark)

   (c) $HOOC-(CH_2)_4-COOH$ (1 mark)

   (d) $CH_3CH_2-O-CH_2CH_3$ (1 mark)

6. Consider the reaction:

   $$2A_{(s)} + 3B_{(g)} \rightarrow C_{(s)} \quad \Delta H = -65\ kJ$$

   State the effect on K_p by:

   (a) increasing pressure; (1 mark)

   (b) increasing temperature; (1 mark)

   (c) adding catalyst; (1 mark)

   (d) adding a booster. (1 mark)

7. Explain why some chemicals are stored in:

(a) brown bottles; (1 mark)

(b) dark rooms; (1 mark)

(c) sealed containers; (1 mark)

(d) under paraffin in closed containers. (1 mark)

8. (a) Explain why sampling is necessary in any chemical analytical process. (2 marks)

(b) Explain why some samples are frozen once transported to a chemistry laboratory. (2 marks)

9. The ionization energies of two metals P and Q are shown in table I.

Table I

Ionization number	1	2	3	4	5
P	500	4500	7000	9500	13500
Q	750	1500	7800	11000	14000

State, with reasons, the valencies of P and Q. (4 marks)

10. 25 cm^3 of a solution containing 1.3 gl^{-1} of acidified potassium permanganate reacted completely with a solution prepared by dissolving 0.385 g of the crystals of $AR\,(NH_4)_2Fe(SO_4)_2.7H_2O$ $(f.wt = 410)$ in 2 M H_2SO_4. Calculate the percentage purity (w/w) of the potassium permanganate sample. (4 marks)

11. (a) The elements with atomic numbers 9, 19, 44 and 78 are either s-block, p-block or d-block. Explain the meaning of the term s-block element. (2 marks)

(b) Write the electronic configuration of the element with atomic number 44 using the aufbau principle. (2 marks)

12. Write a balanced ionic equation of the reaction between acidified $KMnO_4$ and hot sodium oxalate solution; from first principles. (4 marks)

13. Draw the structures of the following organic moleules:

(a) 2,2,3 trichloro, 4 hydroxy pentanoic acid; (2 marks)

(b) diethyl ether; (1 mark)

(c) 3 methyl, 6 ethyl octane. (1 mark)

14. (a) Define molarity; (1 mark)

(b) Calculate the molarity of 20% w/v of NaOH (Na = 23, O = 16, H = 1). (3 marks)

15. State **four** properties of a primary standard. (4 marks)

SECTION B (40 marks)

*Answer any **TWO** questions from this section.*

16. (a) (i) Define the term 'ppm'; (1 mark)

(ii) Describe the preparation of 250 cm^3 of concentration 100 ppm with respect to sodium using AR sodium phosphate (Na = 23, P = 31, O = 16). (8 marks)

(b) A label on a container of concentrated sulphuric acid has the following information:

M.Wt	98.07
assay	99.8
s.g.	1.94
Ferric iron	0.00005
Barium	0.00002
Sulphates	0.0003

(i) Calculate the molarity of the acid; (6 marks)

(ii) Describe the preparation of 2 litres of 4 M H_2SO_4 from the concentrated acid. (5 marks)

17. (a) Define the term pH. (1 mark)

(b) Calculate the pH of 0.1 M HCl. (2 marks)

(c) The dissociation constant, K_a, for ethanoic acid is 1.8×10^{-5} mol dm^{-3}.

(i) Write an expression for K_a. (1 mark)

(ii) Derive an expression relating K_a, molarity (M) and the degree of dissociation, X, of the acid. (5 marks)

(iii) Calculate the pH of 0.1 M ethanoic acid. (4 marks)

(d) A solution containing ethanoic acid and sodium ethanoate is a buffer solution.

(i) Define buffer solution; (1 mark)

(ii) Calculate the pH of a solution which is 1.8 M with respect to sodium ethanoate and 0.1 M with respect to ethanoic acid. (6 marks)

18. (a) Give the equilibria which exists in:

(i) water; (1 mark)

(ii) liquid ammonia; (1 mark)

(b) Explain why both water and liquid ammonia are poor conductors of electricity. (4 marks)

(c) For each of the following substances, indicate with reasons whether a solution in liquid ammonia will be acidic, basic or neutral.

(i) ammonium chloride; (2 marks)

(ii) sodamide ($NaNH_2$) (2 marks)

(iii) potassium hydroxide; (2 marks)

(iv) hydrogen chloride. (2 marks)

(d) Figure 1 refers to a curve of the titration of a 0.1 M monobasic acid with a monoacidic base.

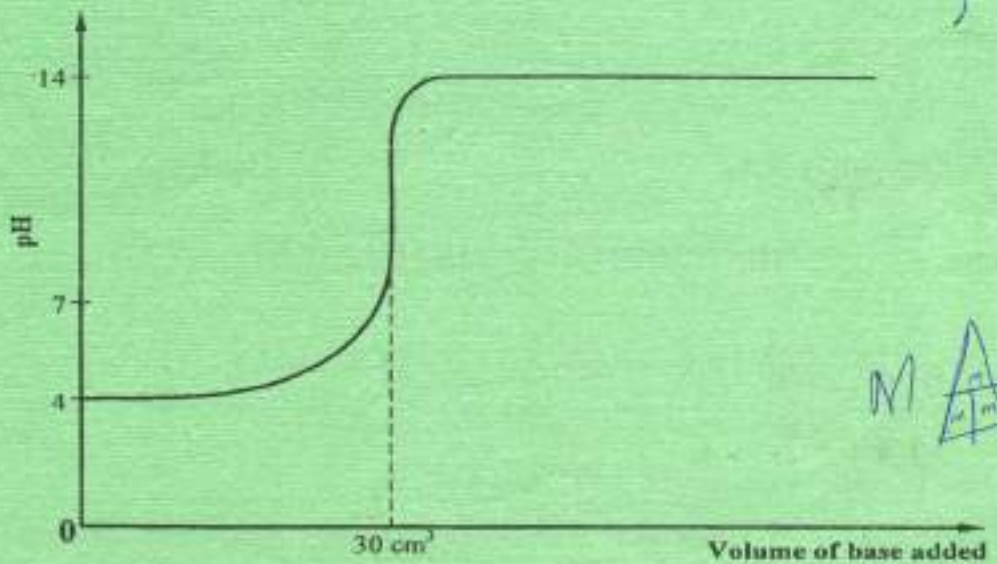

Fig. 1

(i) Explain whether the acid and the base are weak or strong. (4 marks)

(ii) Explain the meaning of the terms monobasic and monoacidic. (2 marks)

19. (a) Define the following terms as used in titrimetry:

(i) aliquot; (1 mark)

(ii) titre. (1 mark)

(b) A 7.5 g sample of the ore malchite, $CuCO_3.Cu(OH)_2$, was dissolved in 100 cm^3 of 1 M HCl. The excess acid was back-titrated with 8.3 cm^3 of 0.05084 M NaOH. Calculate the percentage purity (w/w) of the ore.
(Cu = 63.5, C = 12, O = 16, H = 1). (10 marks)

(c) The active ingredient in a drug used in the treatment of chronic alcoholism is tetraethylthiurandisulphide.

$$(C_2H_5)_2 — NCSS\,NC(C_2H_5)_2 \quad (f.wt = 296.54)$$

(i) State the number of moles of SO_2 produced when one mole of the drug is completely burned in oxygen. (2 marks)

(ii) The sulphur in a 0.4329 g sample of the drug was oxidized to SO_2 which was absorbed in H_2O_2 to form H_2SO_4.

$$H_2O_2 + SO_2 \rightarrow H_2SO_4.$$

The acid was titrated with 0.03736 M NaOH. Calculate the purity w/w of the drug.

(6 marks)

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